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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

First Semester, M. Tech - Mechanical Engineering (MMDN)

Make – up Examination; Feb - 2016

Finite Element Methods

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each **unit**.*

UNIT - I

1 a. Differentiate between the following :

i) Global and Local Coordinate systems — 9

ii) Essential and Natural Boundary Conditions.

b. Highlight the rules to guide the placement of nodes when obtaining approximate solution to differential equation. — 6

c. What is shape function? List the characteristics of shape functions. — 5

2 a. Derive shape functions for quadratic bar element and plot the variation of shape functions along the length of the element. — 8

b. For the composite structure of axially loaded member shown in Fig. 2(b). Find unknown displacement and Reaction forces. — 12

UNIT - II

3 a. Show that shape function for Linear Quadrilateral element is given by

$$N_i = \frac{1}{4}(1+\xi\xi_i)(1+\eta\eta_i)$$ — 8

Where i = *1, 2, 3, 4.*

b. For a Linear triangular element,

$$N_1 = \frac{1}{16}(40-3x-4y)$$

$$N_2 = \frac{1}{16}(-16+4x)$$ — 12

$$N_3 = \frac{1}{16}(-8-x+4y)$$

And μ = 0.3 E = 2 10^5 MPa out t_e = 1. Determine the strain displacement matrix and stiffness matrix for a plane strain element.

4 a. Using Lagrange functions derive shape function for hexahedron (Brick) element. — 8

b. Differentiate between CST and LST element. — 4

c. Evaluate the Jacobian matrix at the local coordinates $\xi = \eta = 0.5$ for the linear quadrilateral element with its global coordinates at (4, 4), (7, 5), (8, 10) and (3, 8) at nodes 1, 2, 3 and 4 respectively. — 8

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UNIT - III

5 a. What is meant by axi-symetric field problem? Give example. List the required conditions for a problem assumed to be axi-symmetric and also write down the relationship between stress and strain for the axi-symmetric problem. 10

b. Derive [B] matrix for an axi-symmetric triangular element. 10

6. For the three bar truss shown in Fig. Q. 6(a) determine the nodal displacements and the – stresses in each member. Find the support reactions also. 20
Take E = 200 GPa, A_1 = 1500 mm^2 and A_2 = A_3 = 2000 mm^2.

UNIT - IV

7 a. Differentiate between Lagrange's and Hermit interpolation function. 4

b. Find the deflection and slopes at the nodes for the aluminium beam shown in Fig. Q. 7(b). 16

8 a. Derive the mass matrix for a 2 noded one dimensional bar element. 6

b. For the bar shown in Fig. Q8(b) determine the first two natural frequencies. 14
Tate E = 210 GPa, ρ = 7860 kg/m^3 A_1 = A_2 = 650 mm^2. Use lumped mass matrix equations.

UNIT - V

9 a. Consider a wall of a tank containing a hot liquid at a temperature T_o with an air stream of temperature T_∞ passed on the outside maintaining a wall temperature of T_w at the boundary specify the governing differential equation for one dimensional heat conduction and specify the boundary conditions. 4

b. A composite slab consists of three materials with thermal conductivities of 20 W/mºC, 30 W/mºC, 50 W/mºC and thickness of 0.3 m, 0.15 m and 0.15 m respectively. The outer surface is at 20ºC and the inner surface is exposed to the convective heat transfer coefficient of 25 W/m^2ºC and a medium at 800ºC. Determine the temperature distribution within the wall. 16

10 a. Derive element conductivity matrix for a i1 neat conduction problem using Galerkin approach. 6

b. Calculate the temperature distribution in a one dimensional fin with the physical properties given in Fig. Q.10 (b). The fin is rectangular in shape and is 8 cm long, 4 cm wide and 1 cm thick. Assume that convection heat loss occurs from the fin. Model the fin by four elements. 14

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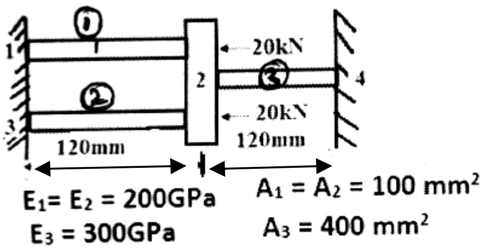

Fig. Q 2(b)

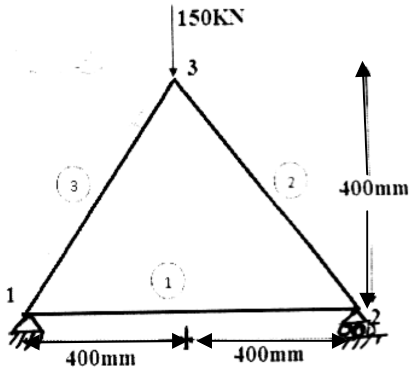

Fig. Q 6

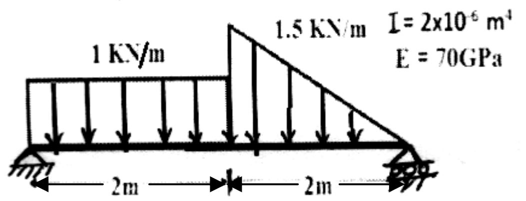

Fig. Q 7(b)

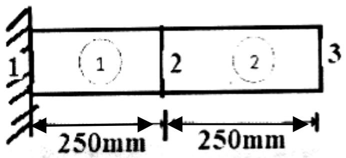

Fig. Q 8(b)

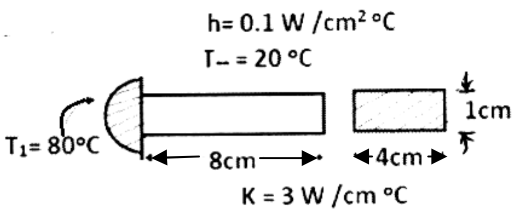

Fig. Q 10(b)

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